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ORTHOSTATIC HYPOTENSION

J. Ninet

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16. Abstract

Basic orientation of the article, by the leader of a group of medical researchers associated with hospitals in Lyon, France, is toward definition and classification. A Table divides OH (orthostatic hypotension) according to physiopathological classification into sympathicotonic and asympathicotonic types and then each of these into primary and secondary with subdivisions. The Figure sketches organization and functioning of the baroreflex arc. Applications to clinical study comprise the physiological study of circulatory reflexes, listing measurement tests and the biological study of hormonal regulation listing the appropriate kinds of studies. Data are not given.

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ORTHOSTATIC HYPOTENSION

J. Ninet
Hopital Edouard-Herriot, Clinique Medicale A (Pres. J. Pasquier)

Determination of a significant pressure drop > or = 40 mm Hg /7* systolic and > or = 20 mm Hg diastolic and persistent (5 min) in the passage from decubitus to orthostasis defines orthostatic hypotension.

It means the deregulation of one or several of the mechanisms which normally maintain tensional homeostasis in orthostasis.

Mechanisms of Physiological Adaptation to Orthostatism

In passage to orthostasis 400-600 ml of blood (0.10 total volemia) proceeding to an extent of 80% from the intrathoracic compartment will accumulate, due to weight, in the low pressure capacitive venous system of the lower half of the body, i. e. the lower members and the splanchnic region. The result is a reduction in venous cardiac reflux, of left ventricular repletion and thus, by Starling's law, of systolic ejection volume, cardiac flow and arterial pressure. If this drop in pressure is not corrected, there will be cerebral ischemic manifestations, since conditions have gone beyond the point where autoregulation of the CNS is possible.

In the healthy subject these phenomena are combatted at once by a series of neuroendocrine mechanisms, basically reflex, which act upon the three determining factors in arterial pressure: cardiac flow (rate times undulated systolic volume), resistance of the peripheral arterioles and circulating blood mass. Thus the pressure drop is discrete, ca 5-10 mm Hg, and very transitory. Correction occurs at second 10 diastolic and seconds 20-60 systolic. Thus average BP remains the same.

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* Numerals in the margin indicate pagination in the foreign text.

TABLE I. ETIOLOGICAL PRINCIPLES OF ORTHOSTATIC HYPOTENSION (OH)
PHYSIOPATHOLOGICAL CLASSIFICATION

SYMPATHICOTONIC OH	ASYMPATHICOTONIC OH
Primary	Primary
	- Bradbury-Eggleston - Shy-Drager
Secondary	Secondary
- iatrogenic (neuroleptic, nitrated)	- iatrogenic (D.L. sympathectomy; ganglioplegic)
- hypovolemia global (dehydration) circulatory (varices, thermodilatation, deadaptation, pregnancy)	- organic
	- peripheral neuropathic (diabetes, porphyria, amylosis)
	- syringomyelia, Biermer
- hyperbradykininism	- Gayet Wernicke

This hemodynamic equilibrium in orthostatism is guaranteed basically by cardiac acceleration of approximately 20% and by a 30% elevation in peripheral resistances. Cardiac flow remains reduced by about 15%, as does also blood volume, due to temporary exaggeration of capillary filtration under hypertension.

a) The autonomic nervous system comprising the baroreflex neurochemical arc

This (see Fig. 1) plays the chief role in such adaptation. The initial drop in pressure brings with it a reduction in the afferent influxes reaching the bulbar vasomotor centers starting from the sinocarotid and aortal baroreceptors. There immediately ensues a removal of the vagal inhibitor and reinforcement of orthosympathetic, and in an accessory way medullosuperrenal, activity giving rise to arteriolar and venous vasoconstriction, tachycardia and improvement in cardiac inotropism.

b) Hormonal Regulation

This has a slower corrective effect.

Stimulation of the renin-angiotensin-aldosterone system (RAAS)

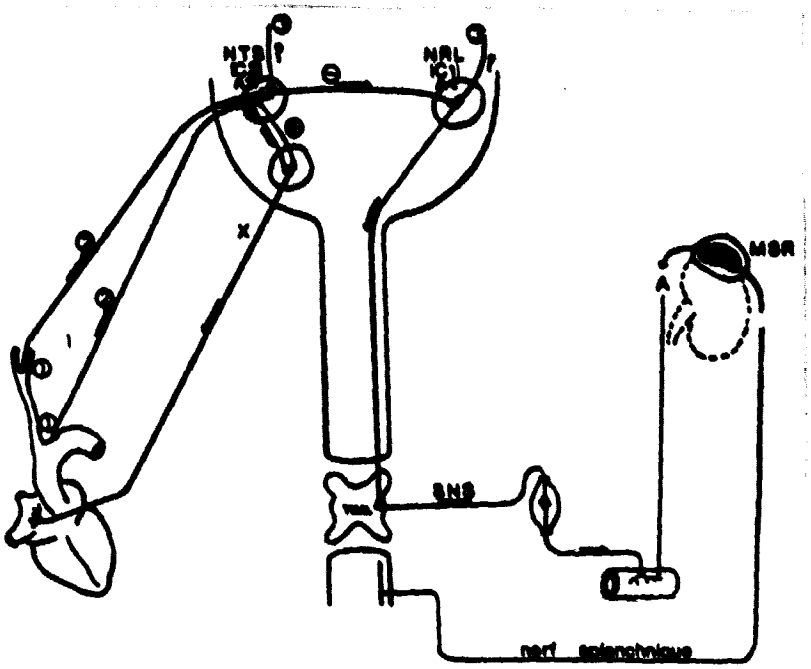

Fig. 1. Organization and Functioning of Baroreflex Arc. Pressure drop perceived by baroreceptors (1). Reduced influx into inhibitor nerves (2) reduces activity of nucleus of tractus solitarius (NTS). This induces:
- through interneuron facilitator (+) and vagus (x) a condition of tachycardia
- through interneuron (-) inhibiting vasomotor center (lateral reticular nucleus NRL) increased activity of bulbospinal pathway leading to tractus intermediolateralis (TIML). Stimulation of sympathetic nervous system (SNS) and medullosuprarenal (MSR) brings on active vasoconstriction through release of norepinephrine (NA) and adrenalin (A).

Key: a. splanchnic nerve

through activation of the intrarenal regulatory mechanisms (baro- and chemoreceptors) as well as the extrarenal ones (sympathetic nervous system, SNS) immediately increases arteriolar resistances by angiotensin and secondarily sodium retention by aldosterone.

Stimulation of secretion of the antidiuretic hormone, in response to information from the central osmoreceptors and atrial voloreceptors, also controls volemia by reducing renal elimination of free water.

c) Importance of Myogenic Regulation

This is objectified by the major drop in pressure induced by passive orthostatism (tilt on a seesaw table) rather than by active. Muscular contraction at the level of the lower limbs and abdomen actually favors venous reflux, as does acceleration of respiratory rhythm.

Etiopathogenic Mechanisms in OH

a) The complexity of the regulatory system and its relative fragility explain the great variety of causes that may involve OH (Table I). Vasoconstrictive insufficiency, by itself or linked with vagal breakdown, plays the chief role in the determination of this involvement. Hypovolemia, whether absolute or relative, is /8 less often responsible. Pathological vasodilatation mediated humorally is exceptional.

b) Two major physiopathic types of OH may be recognized:

The first is sympathicotonic. The orthostatic pressure drop is moderate and accompanied by considerable tachycardia. The baroreflex arc is anatomically intact but cedes its compensatory role to the intensity of the disturbance (functional neurogenic, volemic or myogenic) generating the OH.

The second type is asympathicotonic and is characterized by a deep depression of systolodiastolic pressure but without acceleration adapted to cardiac rate (less than 15/min). Much less frequently it even signalizes serious impairment of the reflex arc itself.

Applications to Clinical Study

Numerous case histories, employed basically for research purposes and particularly in the primary forms, attempt to define exactly the mechanism of OH deregulation and to localize the anatomical or functional problem causing it.

a) Physiological Study of Circulatory Reflexes

A battery of tests is used to study the various components of this reflex by measuring cardiac rate (EKG) and BP (Hg manometer, bleeding method or cardiac catheter). However, the results must be interpreted prudently: some tests are actually negative in a normal subject and most of them are not entirely specific in regard to the pathways they explore.

- The integrity of the total baroreflex arc can be tested in two ways: orthostatism of the type we have shown in the definition or its equivalents which permit us to neglect myogenic regulation (verticalization on the tilting table or lower pressure applied to the inferior half of the body) and the Valsalva (deep inspiration followed by expiratory effort with closed glottis).

- Integrity of bulbar vasomotor centers and efferent sympa- /8
thetic fibers is studied by seeking a hypertensive stress response (to sudden noise, mental arithmetic), response to cold (hand plunged in ice water) and to hypercapnia (inhalation of a CO_2 enriched gas mixture).

- Reactivity of arteriolar receptors is tested by the intensity to the hypertensive response during pharmacological tests with, basically, direct sympathomimetics (norepinephrine), indirect ones (tyramine) or angiotensin. Some authors also study the appearance of hypotension with arteriolar beta stimulants (isoproterenol) or venodilators (trinitrin).

- Integrity of the afferent arc, of the center and of vagal efference is tested by modification of cardiac rhythm with ocular and sinocarotid compression, atropine IV and norepinephrine perfusion.

b) Biological Studies of Hormonal Regulation

This comprises three parts:

- *Study of catecholamines and of dopamine beta hydroxylae (DBH) activity*
  - daily urinary elimination of catecholamines and their metabolites;
  - changes in urinary yield or in amounts of plasma norepinephrine (and in an accessory way of adrenalin and DBH) with postural stimulation;
  - changes in urinary yield of adrenalin (and in an accessory way of norepinephrine and DBH) with insulin hypoglycemia.

- *Study of the renin-angiotensin-system (RAS)*
  - dosage of plasma renin activity and of plasma concentration of aldosterone following 10 hr decubitus with normal sodium diet and different types of stimulation (postural, hypoglycemia, sodium depletion);
  - determination of volemia.

- *Study of antidiuretic hormone with dosage of plasma neurophysines before and after postural stimulation*

c) Study of Extravascular Functions of Autonomic Nervous System

Such studies make it possible to assay the integrity of innervation:

- pupillar innervation by collyria tests (direct and indirect sympathico- and parasympathicomimetic);
- sudorimotor and thermoregulatory innervation by elevating central temperature, injection of parasympathomimetics (acetylcholine, pilocarpine) and cutaneous thermography;
- sphincter, urigenital and rectal innervation by electromyography;
- gastric secretion by chemical processes.

Types of Primary OH

These cannot be properly pictured until secondary causes have been eliminated. Two affections, of very different prognostic importance, must be opposed.

a) Primary Sympathicotonic OH

Observed especially among young women, it is a benign functional disturbance, probably associated with deficient veno-constriction. For a number of authors it would be no more than the initial phase of vasovagal reactions; the hypersympathicotonic condition would disappear abruptly, giving way to a cholinergic discharge and acute orthostatic syncope with bradycardia and hypotension due to vasodepression.

b) Primary Asympathicotonic OH

This affection, very rare, sporadic and familial only by exception (a single case in the literature) ordinarily involves both sexes in their 6th decade. It is linked with extensive degeneration of the autonomic nervous system responsible, on the one hand, for major postural hypotension without adapted tachycardia and, on the other hand, for a concomitant profuse autonomic symptomatology (anhydrosis, thermal intolerance, impotence, vesical incontinence or retention, myosis...).

- The Shy-Drager syndrome associates dysautonomic signs with a central neurological symptomatology, basically extrapyramidal but at times more complex (extrapyramidal + cerebellar + pyramidal + anterior horn...). Setting up of neurological signs habitually follows rapidly upon occurrence of dysautonomic disorders and development involves death within 8 yr on the average. The basic anatomical lesions involve the TIML, the dorsal vagal nucleus, the locus niger and the locus coeruleus. Impairment is more discrete and variable in frequency at the level of the putamen, the cerebellar cortex, the pons nuclei, the bulbar olivae, the anterior horns of the medulla and the sympathetic ganglia.

- In idiopathic OH (Bradbury-Eggleston) the dysautonomic signs are isolated. Survival is much longer and incapacity less due to the absence of neurological involvement. Crossover to Shy-Drager is possible but rare. Localization on the baroreflex arc is still open to discussion for want of sufficient anatomical verification: central and efferent preganglionic lesions as in Shy-Drager or pre-

dominant lesions on the second postganglionic neuron is a decision that remains to be made.

REFERENCES

1. Dysrégulation tensionnelles et affections neurologiques [Pressural Dysregulation and Neurological Affections], in Réanimation et Médecine d'Urgence, 1979, M. Goulon and M. Rapin, edd., Expansion Scientifique Française, pp 169-282.

2. Ninet, J., G. Annat, D. Boisson and L. Holzhapfel, L'hypotension orthostatique [Orthostatic Hypotension], Cah. med. 1980 (in the press).